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VAX-11/780 USING VAX/VMS RELEASE 36(U) FEDERAL SOFTWARE  
TESTING CENTER FALLS CHURCH VA 31 DEC 84  
OIT/FSTC-84/501

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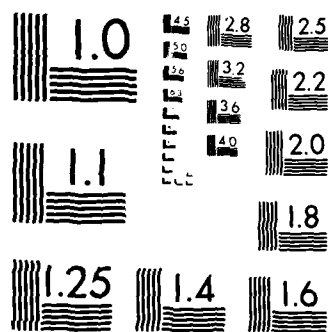
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Ada<sup>®</sup> COMPILER VALIDATION  
SUMMARY REPORT

DEPARTMENT OF THE ARMY,  
COMMUNICATIONS ELECTRONICS  
COMMAND  
ALS AdaVAX Version 1.1  
VAX-11/780  
using VAX/VMS Release 3.6

December 31, 1984

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OFFICE OF SOFTWARE DEVELOPMENT  
AND INFORMATION TECHNOLOGY

**This report has been reviewed and is approved.**

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ABSTRACT

Under US Army Contract DAAK80-C-0507, SofTech, Incorporated -has developed an Ada compilation system for the Department of the Army, Headquarters USA, Communications Electronics Command. The compiler, ALS AdaVAX version 1.25, was tested against version 1.4 of the Ada Compiler Validation Capability (ACVC) test suite on a VAX-11/780 operating under VAX/VMS version 3.6. Version 1.4 of the test suite contained 2185 tests, of which 1943 were applicable to this implementation. Of the applicable tests, 74 were withdrawn due to errors in the tests. Of the remaining applicable correct tests all (1875) passed, and no anomaly was discovered.

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## 1. INTRODUCTION

### 1.1 Purpose of the Validation Summary Report

This report describes the results of the validation effort for the following Ada compiler:

Host Machine: VAX-11/780  
Operating System: VAX/VMS Version 3.6  
Host Disk System: RP07  
Target Machine: VAX-11/780  
Operating System: VAX/VMS Version 3.6  
Language Version: ANSI/MIL-STD-1815A Ada  
Translator Name: ALS AdaVAX  
Translator Version: 1.25  
Validator Version: 1.4

Testing of this compiler was conducted by the Federal Software Testing Center under the supervision of the Ada Validation Office (AVO), at the direction of the Ada Joint Program Office. Testing was conducted from December 3, 1984 through December 7, 1984 at Waltham, Massachusetts in accordance with AVO policies and procedures.

The purpose of this report is to document the results of the testing performed on the compiler, and in particular, to:

- . identify any language constructs supported by the compiler that do not conform to the Ada standard.
- . identify any unsupported language constructs required by the Ada standard:
- . describe implementation-dependent behavior allowed by the standard.

1.2 Use of the Validation Summary Report

The Ada Validation Office may make full and free public disclosure of this report in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of the validation are only for the purpose of satisfying United States Government requirements, and apply only to the computers, operating systems, and compiler version identified in this report.

The Ada Compiler Validation Capability is used to determine insofar as is practical, the degree to which the subject compiler conforms to the Ada standard. Thus, this report is necessarily discretionary and judgemental. The United States Government does not represent or warrant that the statements, or any one of them, set forth in this report are accurate or complete, nor that the subject compiler has no other nonconformances to the Ada standard. This report is not meant to be used for the purpose of publicizing the findings summarized therein.

Question regarding this report or the validation tests used for the validation should be sent to:

Validation Program Manager  
Federal Software Testing Center  
5203 Leesburg Pike, Suite 1100  
Falls Church, VA 22041-3467

1.3 References

Reference Manual for the Ada Programming Language, ANSI/MIL-STD-1815A, February 1983.

Ada Validation Organization: Policies and Procedures, Mitre Corporation, June 1982, PB 83-110601.

Ada Compiler Validation Implementers' Guide, SofTech, Inc., October 1980.

The Ada Compiler Validation Capability, Computer, Vol. 14, No. 6, June 1981.

Using the ACVC Tests, SofTech, Inc. November 1981.

Ada Compiler Validation Plans and Procedures, SofTech, Inc. November 1981.

#### 1.4 Definitions of Terms

Class A tests are passed if no errors are detected at compile time. Although these tests are constructed to be executable, no checks can be performed at run-time to see if the test objective has been met.

Class B tests are illegal programs. These tests pass if all the errors they contain are detected at compile-time (or link-time) and no legal statements are considered illegal by the compiler.

Class L tests consist of illegal programs whose errors cannot be detected until link time. These tests pass if errors are detected prior to beginning execution of the main program.

Class C tests consist of executable self-checking programs. These tests pass if they complete execution and do not report failure.

Class D tests are capacity tests. Since there are no firm criteria for the number of identifiers permitted in a compilation, number of units in a library, etc., a compiler may refuse to compile a class D test. However, if such a test is successfully compiled, it should execute without reporting a failure.

Class E tests provide information about an implementation's interpretation of the Standard. Each test has its own pass/fail criterion.

CUSTOMER: The agency requesting the validation (Department of the Army).

HOST: The computer(s) on which the compiler executes is/are VAX-11/780.

FSTC: Federal Software Testing Center. In the context of this report the FSTC conducts Ada validations under contract to the AVO as a satellite facility.

ACVC: Acronym for the Ada Compiler Validation Capability.

RM: The Ada Language Reference Manual  
(ANSI/MIL-STD-1815A).

IG: ACVC Implementers' Guide.

AVO: The Ada Validation Office. In the context  
of this report the AVO is responsible for  
directing compiler validation.

TARGET: The computer(s) for which the compiler  
generates object code is/are  
VAX-11/780.

VALIDATION: The process of validating a compiler. The  
term is used interchangeably with test or  
compiler test.

VALIDATION TESTS: The generic form used to refer to a set of  
test programs which evaluate how closely a  
compiler conforms to its language specifi-  
cation. In this report, the term will be  
used (unqualified) to mean the ACVC tests.

## 2. TEST ANALYSIS

A summary of tests processed, by class, is given in Exhibit 1, where:

- Pr = processed.
- NA = found to be inapplicable for this implementation.
- Er = found to be incorrect, and withdrawn from the validation.
- P = passed.
- A = anomalies.
- F = failed.
- FE = failed to execute to completion.
- FC = failed to compile successfully.
- Fs = total of all failures (i.e.,  $F+FE+FC$ ).

Exhibit 1 shows that the ALS AdaVAX compiler passed all applicable correct tests.

There were 236 tests in the suite that were processed and found to be not applicable to the ALS AdaVAX compiler (see Section 4.2.7).

In addition, 74 tests were withdrawn from the test suite because they did not conform to the ANSI/MIL-STD-1815A Standard for the Ada Language (see Section 4.2.6 for details.).

### 2.1 Class A Testing

Class A tests check that legal Ada programs can be successfully compiled. These tests are executed but contain no executable self-checking capabilities. There were 58 class A test programs processed in this validation.

#### 2.1.1 Class A Test Procedures

Each class A test was separately compiled and executed. However, the only purpose of execution is to produce a message indicating that the test passed.

#### 2.1.2 Class A Test Results

Successful compilation and execution without any error messages indicates the tests passed. Of the 58 class A tests, 56 passed and 1 was found to be inapplicable. Of these 1 was withdrawn due to errors in the test.

- . CA1012A4M-B.DEP: This test checks whether an implementation requires generic library unit bodies to be compiled in the same compilation as the generic declaration. ALS AdaVAX allows generic declarations and bodies to be compiled in completely separate compilations.
- . BC3204C\*-B.ADA and BC3205D\*-B.ADA: These tests contain a separately compiled generic declaration, some instantiations, and a body. An implementation must reject either the instantiations or the body. ALS AdaVAX rejected the body because of the instantiations.
- . CE2106A-B.DEP and CE3110A-B.DEP: These tests confirmed that dynamic creation and deletion of files is supported.
- . EE3102C-B.ADA: This test confirmed that an Ada program can open an existing file in OUT\_FILE mode, and can create an existing file in either OUT\_FILE or IN\_FILE mode.
- . CE3111A-B.DEP: This test confirmed that more than one internal file could be associated with the same external file provided that both internal files were opened for reading.

#### 4.2.9 Anomalous Test Results

An anomaly is test behavior that suggests the implementation does not conform to the Standard. The test behavior is not, however, considered to demonstrate nonconformance to the Standard for purposes of this validation attempt. The reasons for discounting an anomalous test result vary, depending on the anomaly. The existence of an anomaly sometimes means that new tests should be added to the suite to demonstrate the suspected nonconformance in a more convincing manner. Sometimes, when the anomaly is the result of procedural errors during the validation attempt, the existence of an anomaly requires revisions in validation procedures.

No anomalies were noted for this validation.

#### 4.2.8 Information Derived from the Tests

Processing of the following tests indicated support, as described below for a variety of implementation options examined by the tests.

- . E24101A-B.TST: If a based integer literal has a value exceeding `SYSTEM.MAX_INT`, an implementation may either reject the compilation unit at compile time or raise `NUMERIC_ERROR` at run-time. Raising `NUMERIC_ERROR` at run-time is preferred, since it makes programs compilable for a wider variety of implementations (and the numeric literal might occur in an unexecutable portion of code). This test showed that ALS AdaVAX raised a `NUMERIC_ERROR` at run-time for a compilation unit containing an integer literal exceeding `SYSTEM.MAX_INT`.
- . B26005A.ADA: This test contains all the ASCII control characters in string literals. ALS AdaVAX rejected all of these strings.
- . D29002K-B.ADA: This test declares 1000 identifiers and was passed by ALS AdaVAX.
- . D4A002A-AB.ADA, D4A002B.ADA, D4A004A-AB.ADA, and D4A004B.ADA: These tests contain universal integer calculations requiring 32 and 64 bits of accuracy, i.e., values that exceed `SYSTEM.MAX_INT` are used. An implementation is allowed to reject programs requiring such calculations. ALS AdaVAX passed all these tests.
- . E52103Y-B.ADA, C52104X-B.ADA, C52104Y-B.ADA: These tests declare `BOOLEAN` arrays with `INTEGER'LAST+3` components. An implementation may raise `NUMERIC_ERROR` at the type declaration or `STORAGE_ERROR` when array objects of these types are declared, or it may accept the type and object declarations. ALS AdaVAX raised `NUMERIC_ERROR`.
- . A series of tests (D55A03\*-AB.ADA) check to see what level of loop nesting is allowed by an implementation. Tests containing 65 or fewer nested loops passed.
- . D56001B-AB.ADA contains blocks nested 65 levels deep. This test was passed.



- . CE2102D-B, E, F and G were inapplicable because the implementation does support modes IN\_FILE, OUT\_FILE, and INOUT\_FILE, and also the procedures RESET and DELETE.
- . CE2107A-B, B, C, D, E, CE2110B-B, D, CE3111B-B, C, CE3114B-B and CE3115A-B were inapplicable because this implementation does not support file sharing when more than one internal file is associated with the same external file and the internal files are opened with mode OUT\_FILE.
- . CE2410A-B was inapplicable because of the file specification in the call to TEXT\_IO.CREATE.
- . CE3605A-B was inapplicable because this test requires the implementation to support text lines greater than 255 characters.
- . CE3708A-B was inapplicable because this test at line 24 requires the implicit conversion of the literal 36382 into INTEGER (due to ident\_int). This conversion causes NUMERIC\_ERROR to be raised because the implementation cannot represent the value as an INTEGER.

Results for inapplicable class D and E tests are given in Section 4.2.8.

#### 4.2.7 Description of Inapplicable Tests

The following tests in version 1.4 of the ACVC were considered inapplicable for this implementation for the reasons given below:

- . C24113F-B, C24113G-B, C24113L through C24113Y-B, C35705F through C35705Y-B, C35706F through C35706Y-B, C35707F through C35707Y-B, C35708F through C35708Y-B, C35802F through C35802Y-B, C45241F through C45241Y-B, C45421F through C45421Y-B, C45424F through C45424Y-B, and C45621F through C45621Z-B were inapplicable because they contain tests that exceed the machine capacity using DIGITS precision greater than MAX\_DIGITS = 9.
- . C24113H through C24113K-B were inapplicable because these tests contain literals that exceed the maximum length of 120 characters supported by the ALS AdaVAX compiler.
- . B52004E-AB, B55B09D-AB, B86001CR-AB, C34001D-B and C55B07B-AB were inapplicable because the compiler does not support SHORT\_INTEGER.
- . C34001F-B, C35702A-AB and B86001CP-AB were inapplicable because the compiler does not support SHORT\_FLOAT.
- . B86001DT-AB was inapplicable because the compiler does not support LONG\_LONG\_INTEGER.
- . C35508B-B was inapplicable because of optimization performed by the ALS AdaVAX compiler.
- . C86001E-B was inapplicable because package SYSTEM is used by package TEXT\_IO.
- . C910AHA-B was inapplicable because it attempts to assign SPYNUMB outside range of NATURAL.
- . AE2101C-B, CE2201D-B, CE2201E-B, CE2202A-B and CE2401D-B were inapplicable because this implementation does not allow instantiation of DIRECT\_IO or SEQUENTIAL\_IO with unconstrained array types and record types with discriminants.

- . In C55B15A-B the CONSTRAINT\_ERROR in line 89 should be changed to allow NUMERIC\_ERROR to be raised if LOWERBOUND is less than INTEGER'LAST.
- . In C87B10A-B there are literal values that are outside an integer base type for some implementations.
- . In C87B26B-B at line 119, the attribute STORAGE\_SIZE is applied to a prefix which is an object of an access type. This is illegal; STORAGE\_SIZE is allowed only with a prefix that is an access type/subtype ("is", not "is appropriate for") or for a task type/subtype or object of a task type.
- . An array aggregate with named associations and an 'others' choice must be qualified in an assignment context: C87B31A-B.
- . In C930BDA-B TASKING\_ERROR should be raised; not PROGRAM\_ERROR.
- . C94004A-B assumes report elaborated before package body.
- . In C95008A it was possible for an entry call to call a terminated task, depending on the implementation.
- . In C95009A an unintended race condition in a tasking test allowed a null access value to be dereferenced before the access variable was assigned the access value of an allocated task.
- . The exception handler in lines 87 to 89 does not reflect that exception INCOMPLETE is raised by inner exception handlers for USE\_ERROR. These exceptions will be handled by the OTHERS choice (incorrectly) resulting in "failed". An additional exception handler "WHEN INCOMPLETE => RAISE;" should be added before line 88: CE3103A-B.
- . In CE3804E-B the value 1.35 is incorrectly used for a model number.

- . An incomplete type with discriminants was constrained before its full declaration occurred. An implementation is allowed to reject such subtype indications because of an ambiguity in the language: C38104A-B.
- . The (model) interval used in the test of C (lines 151-152) is too narrow: C45321A,B,..Y-B.
- . The (model) interval used in the test of C (lines 181-182) is too narrow: C45521A,B,..Z-B.
- . The number 23.4 used in lines 28 and 33 is neither a model number of the float subtype FLT nor the anonymous type derived in line 15 (LRM 3.5.7(11)). A model number should have been used instead of 23.4 (e.g. 23.5): C52001B-AB.
- . In line 76, INTEGER'LAST is compared with SYSTEM.MAX\_INT without allowing (by a special exception handler) the implicit conversion of SYSTEM.MAX\_INT to INTEGER (before comparison) to raise NUMERIC\_ERROR. This is an unintended omission in the test program. Line 136 may also (correctly) raise NUMERIC\_ERROR when trying to implicitly convert W\_LIT to INTEGER: C52007A-B.
- . A test assumed that when a constrained array type was declared using a range, e.g., 1..10, that the index subtype was INTEGER instead of INTEGER range 1..10: C52102A-AB and C52102B-AB.
- . These tests attempt a comparison of a null string literal with a variable. Evaluation of the string literal correctly raises CONSTRAINT\_ERROR because the lower bound of the literal is INTEGER'FIRST. The test does not include an exception handler for this exception, and execution terminates abnormally: C52104G-AB.ADA and C52104Q-AB.ADA.
- . In C52103X-B the slice assignment in lines 125 to 127 may raise NUMERIC\_ERROR in the evaluation of the slices or the length test, prior to assignment. Hence, the check performed in lines 147 to 173 may fail because no values have been assigned to the four elements of ARR42 that are tested. The check in lines 147 to 173 should be performed only if no exceptions are raised during the slice assignment of the lines 125 to 127.

#### 4.2.5 Performance Information

The real (i.e., wall clock hh:mm) time required for running was:

- . VAX-11/780 SOFTB 82:49 (stand-alone)
- . VAX-11/780 SOFTC 81:02 (stand-alone)
- . VAX-11/780 SOFTD 86:38 (stand-alone)
- . VAX-11/780 SOFTE 39:06 (shared)

#### 4.2.6 Description of Errors in Withdrawn Tests

The following tests in version 1.4 of the ACVC did not conform to the ANSI Ada standard and were withdrawn for the reasons given below:

- . In A85007D-B, the attribute 'POSITION, 'FIRST\_BIT, 'LAST\_BIT are invalid for variables which are renamed record components.
- . In line 66 of B43201B-B, the 'others' choice in the aggregate which begins on the previous line is marked as being okay. (The first discrete range is static, but the second is not; this does not satisfy the requirements for a static index constraint in the Ada standard, 4.9(11)).
- . B43203B-B checks the legal use of an 'others' choice in array aggregates. In line 80, the test incorrectly indicates that the use of 'others' should be diagnosed in error.
- . The accept statement in B950BAA-B at line 38 is marked as being correct.
- . C37011A-B checks that sliding occurs for initialization of record components that are of an array type. However, 3.2.1(16) of the Ada standard is interpreted as restricting sliding (more precisely, an implicit array subtype conversion) to the initialization of a complete array object (that is, one declared by an "object declaration"; a record component is declared by a "component declaration" according to 3.7(2)).

. illegal external file name2:  
MUCH-TOO-LONG-NAME-FOR-A-FILE

. SYSTEM.PRIORITY'FIRST: 1

. SYSTEM.PRIORITY'LAST: 15

#### 4.2 Testing Information

Tests were compiled/executed at Waltham, Massachusetts.

##### 4.2.1 Pre-Test Procedures

Prior to testing, appropriate values for the compiler-dependent parameters were determined. These values were used to adapt tests that depend on the values. A magnetic tape containing the adapted tests [and split versions of some class B tests (see Section 2.2.2)] was prepared and brought to the testing site.

##### 4.2.2 Control Files

SofTech, Inc., under contract to the Department of the Army, Communications Electronics Command, provided command procedures that compiled and executed tests automatically.

##### 4.2.3 Test Procedures

All files from the version 1.4 tape were read onto disk. The package REPORT and the procedure CHECK-FILE were first compiled and the corresponding library file saved. The tests checking the REPORT package and CHECK-FILE procedure were executed on all four (4) VAX-11/780 used for testing the ALS AdaVAX compiler. Then all the remaining tests were grouped into batch jobs by class and by chapter and processed by four (4) VAX-11/780s.

##### 4.2.4 Test Analysis Procedures

On completion of testing, all results were analyzed for failed class A, C, D, E, or L programs, and all class B compilation results were individually analyzed. Analysis procedures are described for each test class in chapter 2. Tests found to contain errors were withdrawn.

#### 4. ADDITIONAL INFORMATION

This section describes in more detail how the validation was conducted.

##### 4.1 Compiler Parameters

Certain tests do not apply to all Ada compilers, e.g., compilers are not required to support several predefined floating point types, and so tests must be selected based on the predefined types an implementation actually supports. In addition, some tests are parameterized according to the maximum length allowed by an implementation for an identifier (or other lexical element; this is also the maximum line length), the maximum floating point precision supported, etc. The implementation dependent parameters used in performing this validation were:

- . maximum lexical element length: 120 characters
- . maximum digits value for floating point types: 9
- . SYSTEM.MIN\_INT: -2147483648
- . SYSTEM.MAX\_INT: 2147483647
- . predefined numeric types: INTEGER, LONG\_INTEGER, FLOAT, LONG\_FLOAT
- . INTEGER'FIRST: -32768
- . INTEGER'LAST: 32767
- . source character set: ASCII
- . extended ascii chars: "abcdefghijklmnopqrstuvwxyzi!\$?@[ \]^'{}~"
- . non-ascii char type: (NON\_NULL)
- . TEXT\_IO.COUNT'LAST: 32767
- . TEXT\_IO.FIELD'LAST: 32767
- . illegal external file name: BAD-CHARACTER"

### 3. COMPILER NONCONFORMANCES

For this implementation there were no nonconformances or anomalies noted during the official validation. Section 4.2.9 provides a definition of an anomaly and detailed information describing an anomaly if any were noted during the official validation.



2.5.1 Class E Test Results

All 7 class E tests passed. See Section 4.2.8 for further information.

2.6 Class L Testing

Class L tests check that incomplete or illegal Ada programs involving multiple separately compiled source files are detected at link time and are not allowed to execute. There were 60 test programs processed in this validation attempt.

2.6.1 Class L Test Procedures

Each Class L test is separately compiled and execution is attempted. The tests produce FAIL messages if executed. Any "failed" tests are individually checked to see if they are correct and if they are applicable to the implementation. Any tests that are inapplicable or that do not conform to the Ada standard are withdrawn.

2.6.2 Class L Test Results

All 60 class L tests passed.



## 2.2 Class B Testing

Class B tests check the ability to recognize illegal language usage. There were 784 class B tests processed.

### 2.2.1 Class B Test Procedures

Each class B test was separately compiled. The resulting test compilation listings are manually examined to see whether every illegal construct in the test is detected. If all errors are not detected, a version of the test is created that contains only undetected illegal constructs. This revised version is recompiled and the results analyzed. If all errors are still not detected, the revision process is repeated until a revised test contains only a single illegal construct.

A B test is considered to fail only if a version of the test containing a single illegal construct is accepted by the compiler (i.e., an illegal construct is not detected) or a version containing no errors is rejected (i.e., a legal construct is rejected).

### 2.2.2 Class B Test Results

There were 784 class B tests presented to the compiler. Of these tests 5 were found to be inapplicable to this implementation (see Section 4.2.7); 3 tests were found to be incorrect (i.e., a conforming compiler would have failed each of these tests). All 776 remaining class B tests passed.

Because all errors were not detected when compiling the original tests, the following 30 tests were modified and divided into 131 separate units by removing the detected errors; the modified tests were then resubmitted to see if the remaining errors would be detected:

B22003A.ADA	B23002A.ADA	B29001A-B.ADA	B33004A.ADA
B36101A-AB.ADA	B36102A.ADA	B36201A-B.ADA	B37004C-B.ADA
B37004H-B.ADA	B37301A.ADA	B37301B.ADA	B37303A.ADA
B44001A-B.ADA	B45205A-AB.ADA	B54A25A-AB.ADA	B55A01A-AB.ADA
B61005A-B.ADA	B64101A-B.ADA	B65001A.ADA	B67001A-B.ADA
B74207A-B.ADA	B97101A-AB.ADA	B97101E-AB.ADA	B97102A-AB.ADA
BA2001E.ADA	BC10AEB-B.ADA	BC1202B-AB.ADA	BC1202C-AB.ADA
BC1202D-AB.ADA	BC1207A-B.ADA		

Test Class	Pr	NA	Er	P	A	F	FE	FC	Fs
A	58	1	1	56	0	0	0	0	0
B	784	5	3	776	0	0	0	0	0
C	1262	230	70	962	0	0	0	0	0
D	14	0	0	14	0	0	0	0	0
E	7	0	0	7	0	0	0	0	0
L	60	0	0	60	0	0	0	0	0
Total	2185	236	74	1875	0	0	0	0	0

**EXHIBIT 1: Summary of Test Performance**

## 5. SUMMARY AND CONCLUSIONS

The Ada Validation Office identified 2185 of the ACVC version 1.4 tests as being potentially applicable to the validation of the Department of the Army, Communications Electronics Command, ALS AdaVAX compiler hosted on the VAX-11/780. Of these, 74 were withdrawn due to test errors, and 236 were determined to be inapplicable after they were processed. The compiler passed the remaining 1875 tests.

The AVO considers these results to show acceptable compliance to the February 1983 ANSI Ada Reference Manual.

**END**

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